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WATER SUPPLY STUDY, RED RIVER NAVIGATION PLAN OKLAHOMA, TEXAS, ARKANSAS AND LOUISIANA. A STUDY OF THE VALUE OF MUNICIPAL AND INDUSTRIAL WATER SUPPLY OF NAVIGATION IMPROVEMENTS PROPOSED FOR THE MAIN STEM OF RED RIVER FROM ITS MOUTH TO SHREVEPORT, LOUISIANA

Public Health Service
Dallas, Texas

December 1964

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WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN
OKLAHOMA, TEXAS, ARKANSAS, AND LOUISIANA

A Study of the Value to Municipal and Industrial Water Supply of Navigation Improvements Proposed for the Main Stem of Red River from its mouth to Shreveport, Louisiana

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DECEMBER 1964

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WATER SUPPLY STUDY

RED RIVER NAVIGATION PLAN

OKLAHOMA, TEXAS, ARKANSAS, AND LOUISIANA

Abstract

An investigation has been carried out which discloses the value to municipal and industrial water supply of navigation improvements proposed for the main stem of Red River from its mouth to Shreveport, Louisiana. Immediate and future uses of water may be benefited by the improvements investigated. Economic and demographic studies revealed a potential for increased industrial development and population growth, and serve as the foundation for projected water uses.

Prepared for

DEPARTMENT OF THE ARMY

U.S. Army Engineer District

New Orleans, Louisiana

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

DECEMBER 1964

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I. INTRODUCTION

Authority

In a letter dated November 16, 1962, the Corps of Engineers, New Orleans District, requested the Public Health Service to " . . . provide data on needs and values for municipal and industrial water supply and for water quality control . . ." in the Red River basin below Denison Dam, Texas, exclusive of the Black and Ouachita subbasins. 1/ The Corps of Engineers propose completion of an interim report on Red River bank stabilization and navigation improvement (along the main stem) and have requested evaluation of the navigation and bank stabilization works as the first phase leading up to their later comprehensive basin report. 2/

Purpose and Scope

The purpose of this study was to determine the water requirements to the years 2025 and 2075 along the main stem of the Red River downstream from Denison Dam, Texas, and how these needs may be met. An estimate of the average annual value of benefits to municipal and industrial uses which could be ascribed to the proposed navigation works is evolved from projected economic developments and anticipated needs for water supply.

Acknowledgments

The assistance and cooperation of agencies and individuals who provided data for this report are gratefully acknowledged. These include:

Red River Valley Association
Arkansas Water Pollution Control Commission
Arkansas State Department of Health
Louisiana State Board of Health
Louisiana Stream Control Commission
Texas Water Commission
Texas State Department of Health
Corps of Engineers
Geological Survey
Water utilities and municipal officials at Shreveport and Alexandria, Louisiana

II. SUMMARY AND CONCLUSIONS

Summary

1. The U.S. Army Corps of Engineers is studying bank stabilization and navigation along the main stem of Red River bordering Oklahoma, Texas, Arkansas, and Louisiana, and extending through Louisiana to the Mississippi River. (See Location Map at the back of this report.) Consideration of bank stabilization and navigation is the first step in the Corps' comprehensive study of the Red River basin below Denison Dam, Texas.

2. Red River is unsuitable for most municipal and industrial uses during low flow conditions due to its high dissolved solids and chlorides content.

3. Red River below Denison Dam, Texas, traverses prairie grasslands and river bottom forests. Mean annual temperature is 65° F., while mean annual rainfall ranges from 37 inches at the upper end of the area to 60 inches at the lower end.

4. Major industries in the area adjoining the main stem of Red River are food and kindred products, lumber and wood products, petroleum and coal products, and apparel and related products.

5. Population of the study area has grown from 556,605 in 1910 to 795,931 in 1960. During that time, the urban segment of the area's population has more than quadrupled, from 112,913 in 1910 to 462,914 in 1960.

6. Principal population centers on the river are Shreveport and Alexandria, Louisiana.

Conclusions

1. Population of the study area to be served by municipal water systems is expected to reach 1,845,000 by the year 2025, and total projected municipal water needed to serve that population is 275 million gallons daily (mgd). By 2075, study area municipal water needs of 565 mgd will serve a population of 3,915,000.

2. Industrial water requirements will increase principally as the result of use in petrochemical manufacture, petroleum refining, thermal electric power production, pulp and paper manufacture, and food and kindred

products processing. Total industrial water needed in 2025 is estimated to be 428 mgd, of which 233 mgd is cooling water. Industrial water needs by 2075 will total 731 mgd, of which 319 mgd is cooling water.

3. Municipal and industrial water use in the portion of the study area benefited by the navigation projects' effect on water quality is expected to total 538 mgd by 2025 and 966 mgd by 2075; of which, 208 mgd and 276 mgd will be used for cooling purposes in 2025 and 2075, respectively.

4. Changes in channel width, depth, and flow characteristics to provide for navigation will result in water quality improvement by reducing turbidity, and decreasing chemical quality variations. Also, an improvement in physical convenience for the benefit of users of Red River water will result from maintaining the river stage at higher levels, and reducing pumping heads. These benefits will be available only in that reach of Red River affected by the proposed navigation improvements, i.e., from Shreveport downstream.

   Based upon reduced water treatment and pumping costs to future users of Red River along the main stem navigation project, the value of the benefits is estimated to be $160,400 annually.

III. DESCRIPTION OF PROJECT

The Corps of Engineers, New Orleans District, in cooperation with the Tulsa District, is making a review of Red River below Denison Dam, Texas, for the development of a comprehensive, integrated plan of improvement by means of levees, bank stabilization, and channel improvement for navigation, flood control, and preservation of land in the main valley of Red River.

The proposed navigation improvements will consist of six locks and dams on the main stem of Red River which will make navigation possible up to Shreveport, Louisiana, (See Location Map, figure III-1, at the back of this report), and three locks on Cypress Bayou, which will make navigation possible to the vicinity of Daingerfield, Texas. Upstream from Shreveport, Louisiana (Lock and Dam No. 6), on the main stem of Red River, realignment of the channel will be for bank stabilization only. Levees will be constructed at various locations for flood protection. 3/

The main stem project as proposed will extend along 307.3 miles, while the Cypress Bayou section is planned to be 78.7 miles long.

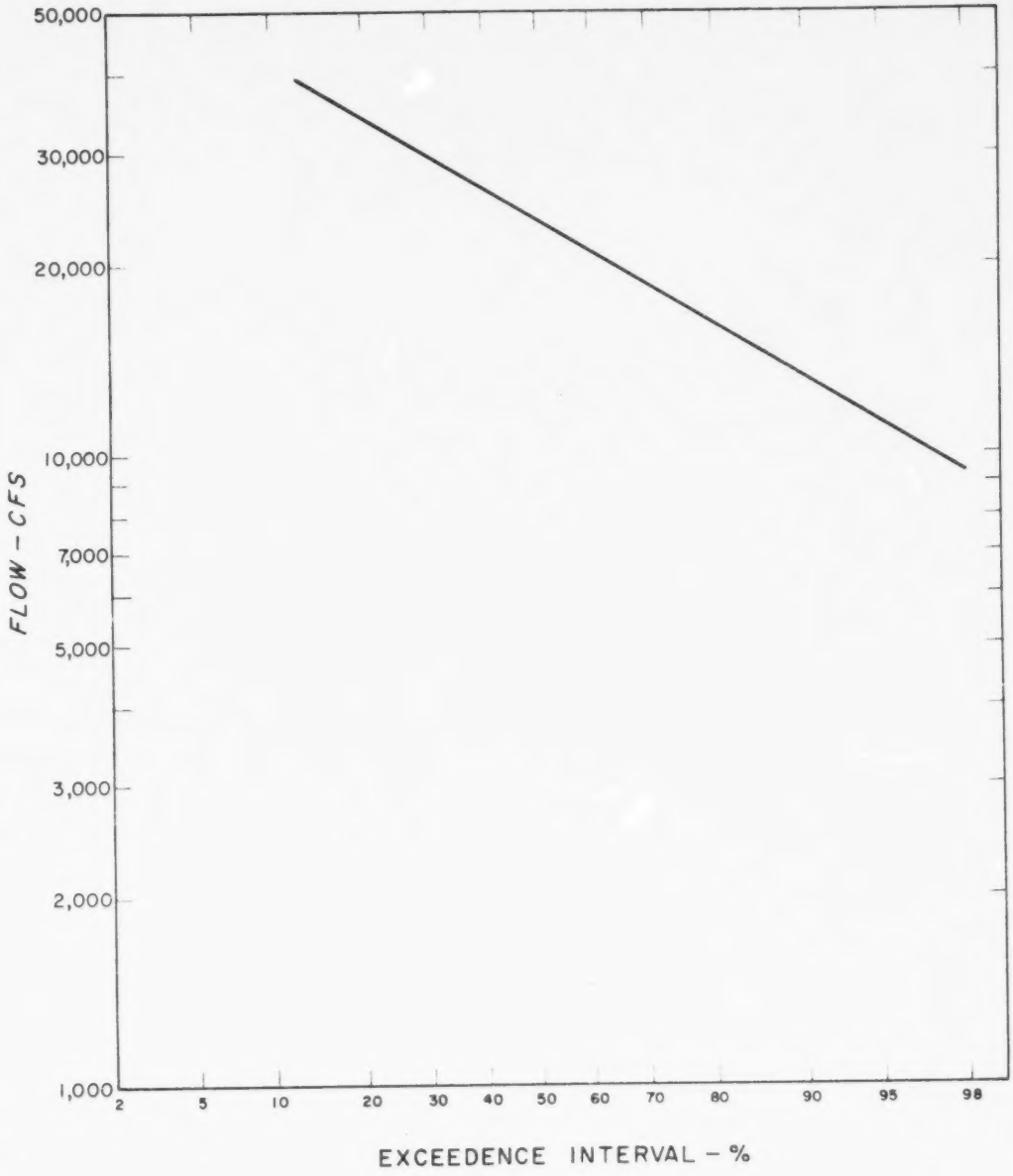
Streamflow

The depth of flow in Red River will be altered to facilitate navigation. As proposed, no new flow regulation reservoirs will be required, i.e., existing flow patterns will be adequate to serve proposed main stem navigation requirements. Figure III-2 presents the annual discharge frequency, while figure III-3 illustrates the discharge duration relationship at Shreveport, Louisiana.

Alteration of depth of flow will modify stream velocities in navigation pools. Figure III-4 shows the effect of the proposed navigation locks and dams on stream velocity in a typical pool.

Water Quality

Red River, in the reach to be affected by the proposed navigation project, is suitable for use as a source of raw water supply except during periods of extreme low flow. During these times, which may extend for as much as two months, dissolved solids, chlorides, and sulfates concentrations exceed acceptable limits of the Public Health Service drinking water standards. 4/ Table III-1 summarizes water quality in Red River within the main stem project area.

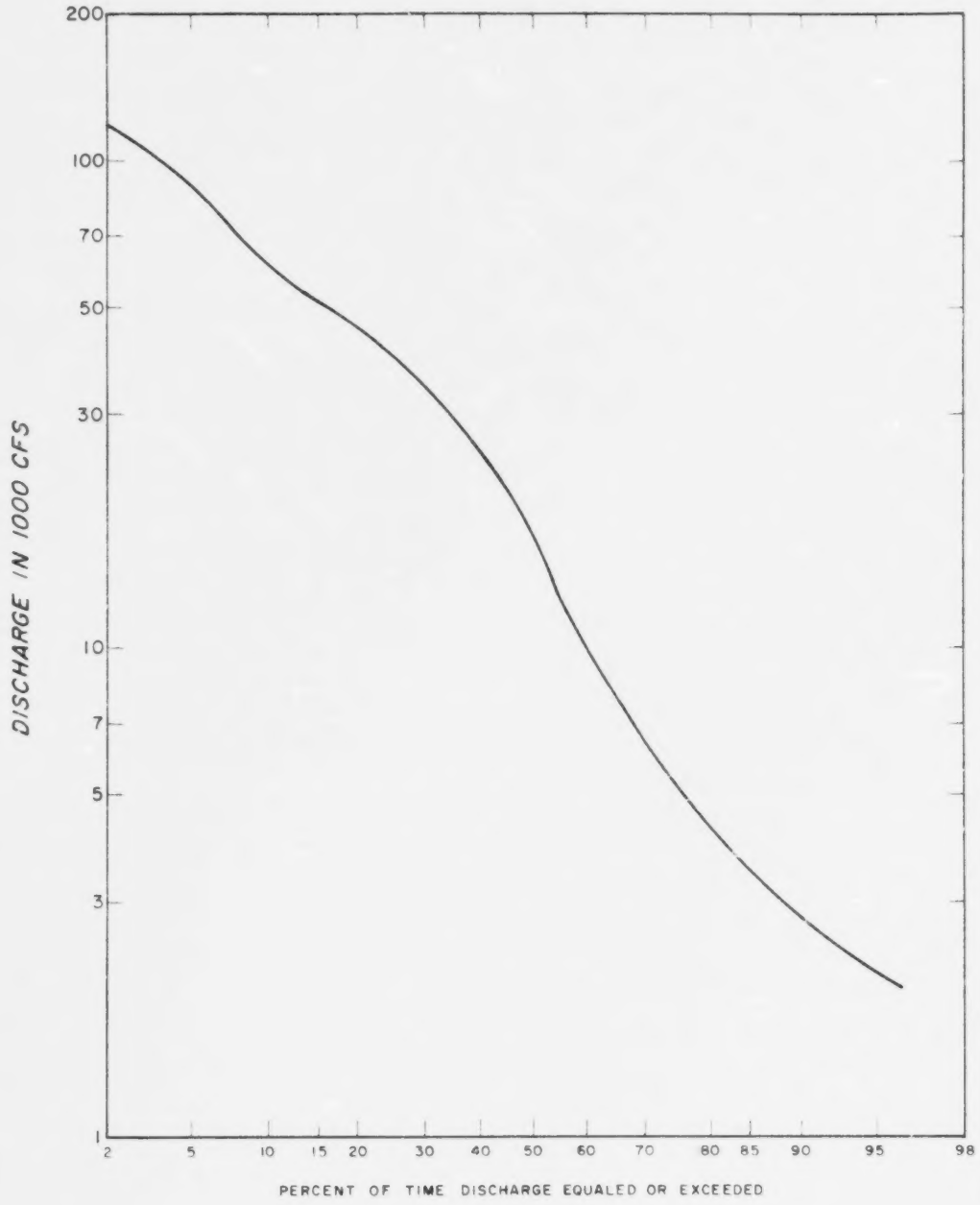


WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN

ANNUAL DISCHARGE FREQUENCY
RED RIVER AT SHREVEPORT, LOUISIANA

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III-2



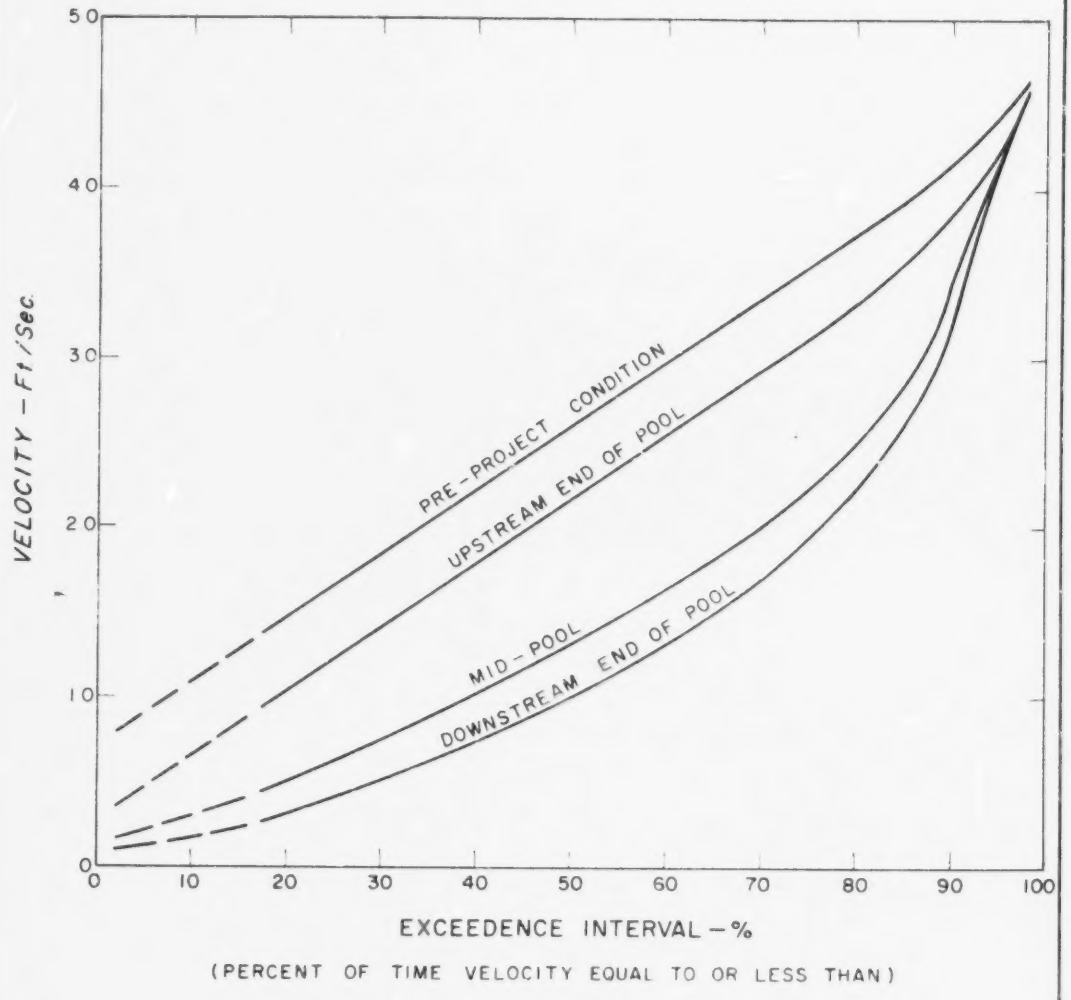
SOURCE: CORPS OF ENGINEERS

WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN

DISCHARGE-DURATION
RED RIVER AT SHREVEPORT, LOUISIANA

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III-3



SOURCE: CORPS OF ENGINEERS

WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN

EFFECTS OF NAVIGATION POOL ON VELOCITY

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III-4

Table III-1

Chemical Characteristics of Red River Water at Shreveport, Louisiana, 1956, 1957, 1958

	Average Discharge (cfs)	Sulfates			Chlorides			Dissolved Solids		
		Weighted Average (mg/1)	Maximum (mg/1)	Minimum (mg/1)	Weighted Average (mg/1)	Maximum (mg/1)	Minimum (mg/1)	Weighted Average (mg/1)	Maximum (mg/1)	Minimum (mg/1)
1956*	9,800	148	281	24	213	410	29	694	1,220	150
1957*	40,700	77	283	14	117	410	16	420	1,220	122
1958*	38,500	43	113	16	62	169	13	276	511	137

* Water year October through September.

Source: Geological Survey 5/

13

IV. DESCRIPTION OF STUDY AREA

The lower Red River basin, in which the proposed navigation project will be located, extends approximately 307 river miles upstream in a general northwesterly direction, from the confluence of Old River, Atchafalaya, and Red Rivers to Fulton, Arkansas. Red River then turns west to form the southern State line of the State of Oklahoma (part of northern State line of Texas). The study area terminates at Denison Dam, a Corps of Engineers multipurpose project which forms Lake Texoma.

Since this study is concerned only with effects of proposed works along the main stem of Red River, the study area was limited to those areas immediately adjoining Red River, which may be affected by the proposed main stem works. This area lies within Bryan, Choctaw, and McCurtain Counties, Oklahoma; Bowie, Fannin, Grayson, Lamar, and Red River Counties, Texas; Hempstead, Lafayette, Little River, and Miller Counties, Arkansas; and Caddo, Bossier, Grant, Natchitoches, Rapides, and Red River Parishes, Louisiana.

Downstream from Denison Dam, Texas, Red River flows through an alluvial valley bordered by low rolling hills. The valley is narrow in the upper reach, where it passes through the cross timbers region. The valley opens out to a maximum width of 9 miles upon entering the Coastal Plain region in the vicinity of the Oklahoma-Arkansas State lines. Red River, downstream from here, is entirely within the west Gulf Coast Plain with the main stem having a low gradient, flowing through an erodible alluvial plain 2 to 12 miles wide. 6/

The area is characterized by a warm humid climate with average annual temperature ranging from 60° to 66° F., and rainfall ranging from 37 inches in the western section to 60 inches in the east. 6/ The increase in precipitation from west to east produces a marked effect in foliage, with the basin becoming more heavily wooded in the east.

Shreveport and Alexandria, Louisiana, are the principal communities along the main stem of Red River. Major economic endeavors are agriculture, forestry, and manufacturing industries. Petroleum refining, petrochemical production, and food and kindred products processing are the most significant water-using manufacturing activities.

V. THE ECONOMY

An economic appraisal was made of the study area. The resulting projections serve as a basis for estimating future municipal and industrial water requirements.

Present

Employment

Employment data shown in table V-1 reflect the major changes in composition of the labor force between 1940 and 1960.

Table V-1

Study Area Employment
1940, 1950, and 1960

	1940		1950		1960	
	Number	Percent	Number	Percent	Number	Percent
Agriculture*	95,559	33.45	54,096	20.92	23,354	8.79
Mining	4,257	1.49	5,160	1.99	4,636	1.74
Manufacturing	24,499	8.57	29,021	11.22	37,561	14.13
Construction	10,347	3.62	16,914	6.54	18,685	7.03
Service Industries	111,075	38.88	143,174	55.36	167,189	62.90
Unemployed	39,983	13.99	10,281	3.97	14,393	5.41
Total Labor Force	285,720	100.00	258,646	100.00	265,818	100.00

* Includes Forestry and Fisheries.

Source: Bureau of the Census 1/

Agriculture

Agriculture in the study area has experienced some significant changes, not only in the loss of jobs of over 75 percent between 1940 and 1960, but also a shift in emphasis to livestock production. Table V-2 illustrates this gain, with 31 percent of total farm sales in 1944 resulting from livestock, compared with 54 percent in 1959, while crop sales remained essentially unchanged.

Table V-2

Agricultural Statistics for the Study Area
1944-1959

	1944	1949	1954	1959
Number of Farms	54,539	48,689	39,871	26,826
Acres of Cropland Harvested	1,855,051	1,693,888	1,330,177	1,052,196
Value* of all Crops Sold	49,538	62,722	48,803	52,075
Value* of all Livestock and Livestock Products Sold	22,574	25,137	26,756	59,942
Total Value* of all Farm Products Sold	72,112	87,859	75,559	112,017

* All values in 1,000's of 1960 dollars.

Source: Bureau of the Census 8/

Mining

Annual value of mineral production has declined more than 10 percent since a peak year in 1955. (See table V-3.) Petroleum, natural gas, and natural gas liquids accounted for most of the value of mineral production with northwest Louisiana and southwest Arkansas providing roughly 75 percent. Other minerals extracted include sand and gravel, as well as clay and stone.

Table V-3

Value of Mineral Production in the Study Area
1953-1960

Year	Value*	Year	Value*
1953	92,826	1957	125,539
1954	117,278	1958	122,957
1955	132,074	1959	112,459
1956	129,163	1961	114,238

* All values in 1,000's of 1960 dollars.

Source: Bureau of Mines 9/

Manufacturing

Manufacturing employment has shown a modest gain from 8½ percent of the labor force of the study area in 1940 to 14 percent in 1960. Table V-4 summarizes the value added by manufacturing. Fabricated metals, food and kindred products, and furniture, lumber, and other wood products lead all other industries in employment in the study area.

Table V-4

Manufacturing Activity in the Study Area
1939-1958

Year	Number of Establishments	Value* Added
1939	520	32,657
1947	717	106,379
1954	793	166,784
1958	862	191,355

* Values in 1,000's of 1960 dollars.

Source: Bureau of the Census 10/

Population

As shown in table V-5, the study area population has undergone a general increase beginning in 1910 with only the decade between 1940 and 1950 having a slight loss. During this time, urban population within the study area quadrupled. Major increased were experienced at Shreveport (Caddo Parish), and Alexandria (Rapides Parish).

Table V-5

Study Area Population - 1910-1960

Year	Total Population	Urban Population
1910	556,605	112,913
1920	684,870	167,809
1930	708,858	217,056
1940	775,752	259,927
1950	764,931	353,127
1960	795,931	462,914

Source: Bureau of the Census 11/

Future

Four factors play a role in the future economic development prospects of the lower Red River study area. These are (1) the state of the national economy, (2) the oil and gas, timber, and other natural resource situation, (3) the geographic location of the lower Red River basin, and (4) the navigation project presently under consideration.

The condition of the national economy is best indicated by its growth rate as measured by population, employment, and gross national product (GNP). According to the Economic Task Group of the AD HOC Water Resources Council Staff, the population of the Nation will reach 502 million by 2020, an increase of 178 percent; employment will reach 197 million, an increase of 186 percent; and the GNP will reach $4.5 trillion, an increase of 778 percent. 12/ These expectations indicate a thriving national economy in which the lower Red River basin will participate. That is, the future prospects of the basin are closely related to national conditions.

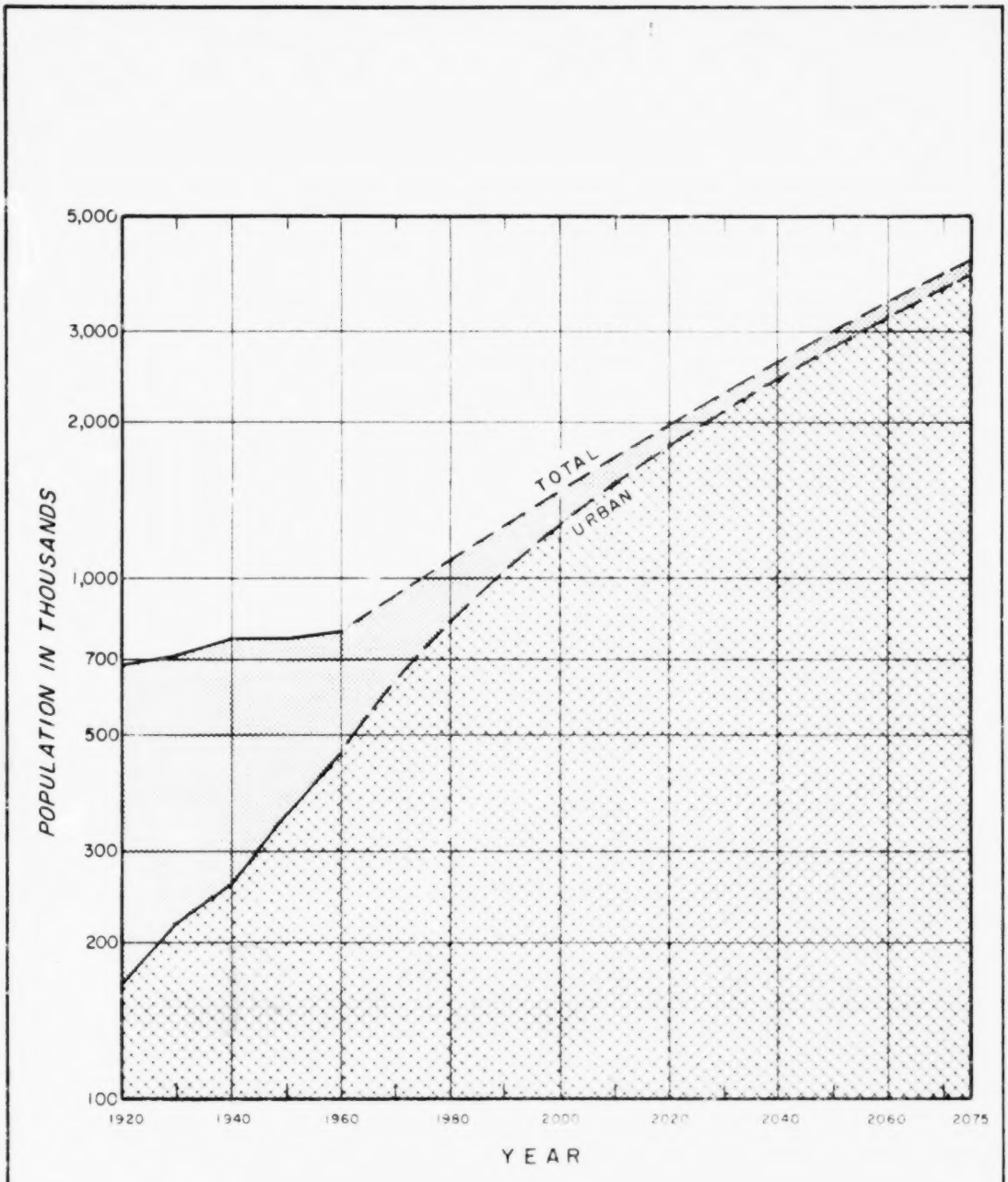
Oil and gas production is expected to hold its place of importance in the regional economic pattern to increase sufficiently to provide feedstock for the petrochemical industry. Low cost water transportation and growing nearby markets for petrochemical products should stimulate processing locally produced oil and gas.

The forest industry in the study area is expected to continue to devote more land to softwoods with less land being utilized for hardwood. Pulpwood produced by study area forests will provide raw material for an expansion of the pulp and paper industry.

The lower Red River basin is well located with respect to growing markets in the midwest and the "space age crescent" along the Gulf Coast.

The area's climatic advantages form an attraction for "foot loose industries" which can locate without considering resources or market availability. Such industry usually finds the needed labor force has already recognized the climatic advantage. This is true in the study area, since the labor force is available to accommodate industrial expansion. The mobility of labor within the study area allows movement of people to areas where industry develops.

Future developments and expansion of significant water-using industries within the study area are of particular importance in evaluating the effect of the proposed navigation project on water quality. Potential heavy water-using industries for which expansion can be anticipated along the main stem of the lower Red River are thermal electric power production, petroleum refining, petrochemical manufacture, pulp and paper production, and food and kindred products processing.



WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN

POPULATION TRENDS & PROJECTIONS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

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FIGURE V-1

Population

Total study area population is expected to reach 2,115,000 in 2025 and 4,190,000 in 2075, as shown in table V-6 and figure V-1. Most of this growth is expected in the urban component of the population in and around the two major centers, Shreveport and Alexandria, Louisiana.

Table V-6

Population of the Study Area
1960, 2025, and 2075

Year	Total	Urban
1960	795,931	462,914
2025	2,115,000	1,845,000
2075	4,190,000	3,915,000

VI. WATER REQUIREMENTS

Municipal and industrial water use is affected by various factors in the economy, the salient features of which were presented in the preceding chapter (V). Those elements which have influenced water use in the past serve as guides in projecting requirements for municipal and industrial purposes.

Municipal

Municipal water needs include residential, public, commercial, and those industrial requirements which are served by organized public water supply systems and are reflected in a per capita use figure. Included are distribution system losses, water use for backwashing filters, together with other treatment plant losses, and evaporation from receiving reservoirs.

Quality requirements for municipal water supplies are described in detail in Public Health Service Drinking Water Standards, 1962.4/ These standards, in general, relate to water at the consumer's tap as contrasted with water at the source of supply, i.e., the standards apply to water after treatment.

Future Needs

Future municipal water need is estimated by multiplying anticipated per capita use by projected study area population expected to be served by public water supply systems. Per capita use by 2025 is expected to vary within the study area from a low of 125 gallons per capita day (gpcd) in the lower (eastern) end of the study area to 175 gpcd in the upper (western) portion of the study area. 13/ It is anticipated that municipal use will average 275 mgd in 2025 and 565 mgd in 2075 in the study area along the main stem of Red River.

Water supply systems in the area adjoining the navigation project alone are expected to serve an estimated population of 1,405,000 in 2025 and 2,970,000 by 2075 with an average of 203 mgd in 2025 and 426 mgd in 2075.

Industrial

Industrial water requirements include the demands for water supply exerted by the principal water-using industries.

Quality requirements of industrial water users vary over a wide range. In general, stream waters which are capable of being treated to meet municipal use quality standards will be suitable for most industrial uses with treatment as required. However, in many situations, the treated water quality standards for industrial users are more rigid than the quality requirements for municipal users.

Since water quality is the major consideration in this study, industrial needs were investigated and projected in two quality groups. The first, high quality, is water of quality equivalent to that provided for municipal purposes, and will be treated to remove turbidity, color, hardness, and other substances as required. The second, low quality, has a minimum of quality restrictions, and is usually used without much treatment. High quality uses are associated with process or contact use. Low quality uses such as cooling waters (do not contact or take direct part in the manufacturing process) usually need not meet the high quality requirements.

Principal high quality water users within the study area are the pulp and paper products, and food and kindred products industries. Industries expected within the study area capable of operating satisfactorily without large quantities of high quality water are thermal electric power, petroleum refining, and petrochemicals which are significant cooling water users.

Future Needs

Projections of industrial water requirements are based upon water needed for use to produce a projected number of product units. Industrial water need projections developed for the "Water Quality Conservation, Arkansas-Red River Basins" were modified, as required, for use in this study. 13/ Industrial water needs, as projected for the lower Red River study area, are 195 mgd and 412 mgd for high quality water for the years 2025 and 2075 respectively, along with 233 mgd and 319 mgd respectively for 2025 and 2075 low quality water requirements. These industrial water requirements have been adjusted to take into account regional differences in industrial practice and anticipated recirculation and reuse of water.

Only a portion of the projected study area industrial water use will be along the main stem navigation project. By 2025, in this part of the study area, industrial water needs will total 335 mgd of which 127 mgd will be for high quality water supply. By 2075, high quality water needs will have more than doubled to 264 mgd, while total industrial needs will be 540 mgd.

Plan to Meet Municipal and Industrial Water Supply Needs - Lower Red Basin

Two general locations along the lower Red River, the areas adjoining Shreveport and Alexandria, could use the main stem to meet future water supply requirements if the chemical quality is improved to a suitable level. Unregulated streamflows in both areas are capable of meeting projected needs.

VII. BENEFITS

Channel improvement for navigation as proposed by the Corps of Engineers will benefit municipal and industrial water supply by improving the physical quality of water available to users along the proposed project. In addition, the proposed works will improve the physical convenience of Red River for water supply use.

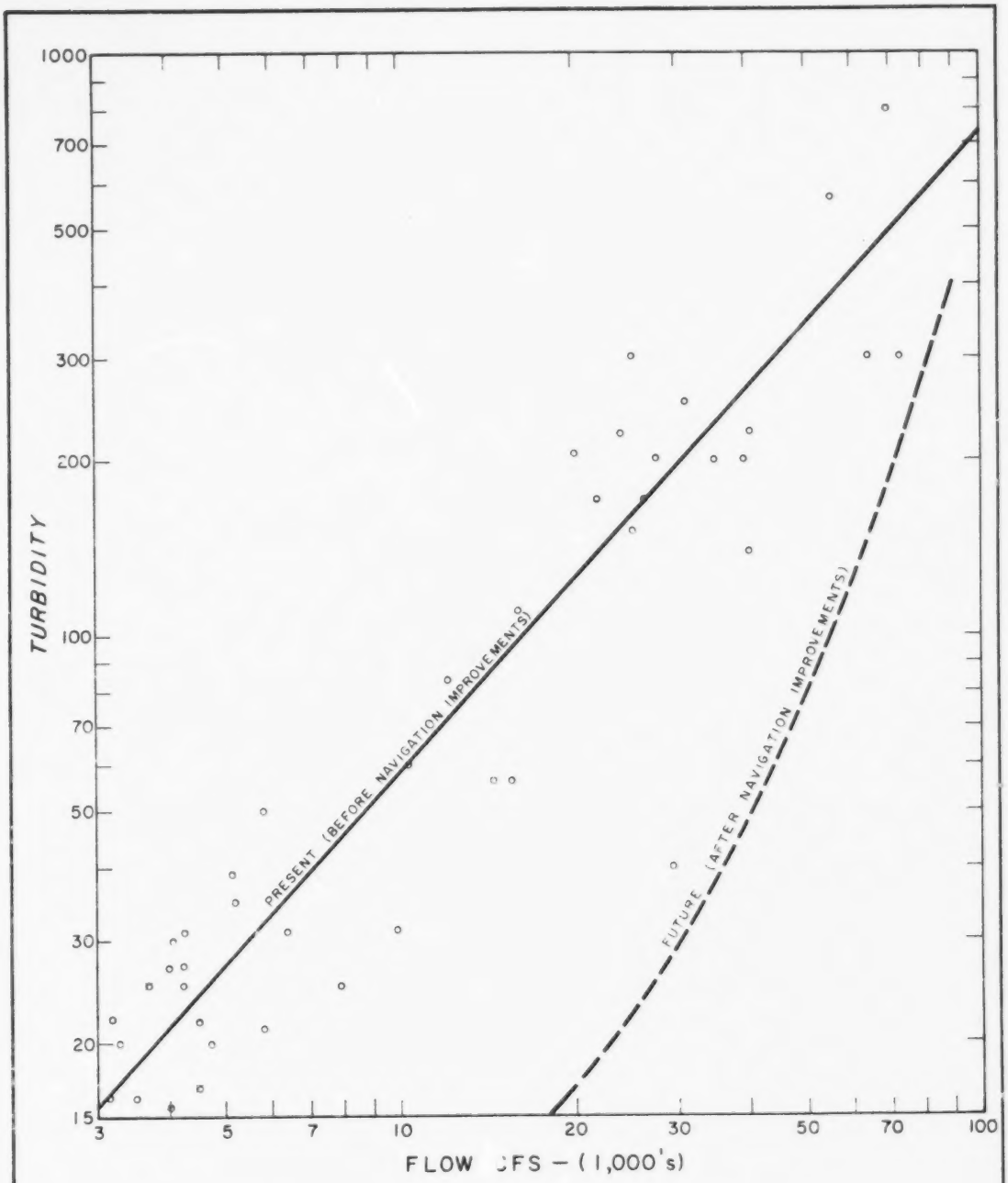
While the proposed improvements will benefit municipal and industrial water supply, recognition should be given to their effect on natural purification characteristics of the stream. These characteristics are expected to be altered by transformation of the river from a free-flowing stream to a series of slack water pools. The effect of the proposed channel modifications on natural purification is complex, being affected by tributary contribution and overall flow regulation. Flow regulation needs will be studied and benefits resulting will be based upon the assumption that adequate treatment or control of wastes will be provided at the source. The scope of this interim investigation was limited to main stem considerations exclusive of flow regulation, which is being investigated by the Public Health Service for the Corps of Engineers' comprehensive study. A water supply and pollution abatement plan is being evolved by the Public Health Service to facilitate evaluation of water supply and quality control storage needs of the Corps' comprehensive plan which is now under development for Red River basin below Denison Dam, Texas.

Quality Improvement

Turbidity is caused by suspended and colloidal matter in water. Sediment producing visible turbidity is ordinarily composed of fine particles of sand and clay. 14/ A stream's carrying capacity for these fine particles is a function of its velocity. Figure VII-1 illustrates the relationship of discharge and turbidity in the unimproved and an improved channel at Shreveport. The proposed navigation improvements to the channel will result in reduced velocities (see figure III-4) and thus will effect a reduction in turbidity. This decrease in turbidity will permit reduced chemical dosages in providing treated water of suitable quality for municipal and industrial process use.

The proposed navigation pools likewise will act as equalizing basins to smooth out other quality variations such as those which occur in dissolved solids, chlorides, and sulfates, i.e., maximum concentrations will be reduced, minimum concentrations will be increased, with a tendency toward the weighted average. A more consistent quality is an intangible benefit.

Bank stabilization is not expected to significantly affect, either physically or chemically, the quality of Red River.



WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN

DISCHARGE VS. TURBIDITY

SHREVEPORT, LOUISIANA

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE VII-1

Physical Convenience

The proposed navigation improvements will maintain Red River at constantly higher levels. This will provide for reduced low service lifts from the stream to water treatment plants or points of use. Appearances are that the net reduction will average 8 feet. 15/

Evaluation of Benefits

Currently, due to wide fluctuations in chemical quality, Red River remains largely unused for municipal and industrial water supply purposes. (Bossier City, Louisiana, across the river from Shreveport has used Red River as a source of water supply since 1959.) Assuming continued improvement of chemical quality due to pollution abatement activity upstream from the study area, and additional flow regulation resulting from projects currently under construction, nearly all water requirements along the main stem are anticipated to be served from the main stem of the Red River (in the areas of improvement). In the event that these upstream improvements take place, construction of the navigation project will provide additional benefits for water supply in these areas by reducing sediment and by reducing pumping costs as described below.

The value of this benefit resulting from the proposed navigation improvements will be proportional to high quality water use. Assuming that use will begin simultaneously with completion of the proposed improvements and would increase in step with economic growth, the 1975 worth of the quality improvement benefits resulting from reduced treatment costs realized from the proposed navigation improvements is estimated to be $4,188,500 or $137,200 annually (at 3 1/8 percent interest for 100 years). Details of the value computations are appended to this report.

The value of the benefits to physical convenience will be proportional to all municipal and industrial use (both high quality and cooling water) of Red River. As with the quality improvement benefits, value is attributable upon completion of the improvements and will increase in step with economic (and water use) growth. The 1975 worth of physical convenience benefits is estimated to be $733,700 or $23,200 annually (at 3 1/8 percent for 100 years) based upon the details appended to this report.

VIII. BIBLIOGRAPHY

1. Corps of Engineers letter dated November 1[illegible], 1962.

2. Summary of Conference, April 3, 1963.

3. Corps of Engineers, Comprehensive Review of Red River and Tributaries, Final Work Plan, New Orleans, May 1964.

4. Public Health Service, Public Health Service Drinking Water Standards, 1962, Washington, Government Printing Office, 1962 (PHS Publication No. 956).

5. Geological Survey, Quality of Surface Waters of the United States 1956, 1957, 1958, Washington, Government Printing Office.

6. Arkansas-White-Red Basins Inter-Agency Committee 1955, "Water Resources Project Data," Volume B, Part II, Section 2.

7. Bureau of the Census, Census of Population, 1940-1960, "Characteristics of the Population," Volume II, Washington, Government Printing Office.

8. Bureau of the Census, Census of Agriculture, 1944-1959, Volume I, Washington, Government Printing Office.

9. Bureau of Mines, Minerals Yearbook, Volume III, "Area Reports," for years 1953 through 1960, Washington, Government Printing Office.

10. Bureau of the Census, Census of Manfactures, 1939-1958, Volume III, Washington, Government Printing Office.

11. Bureau of the Census, Census of Population, 1910-1960, "Number of Inhabitants," Washington Government Printing Office.

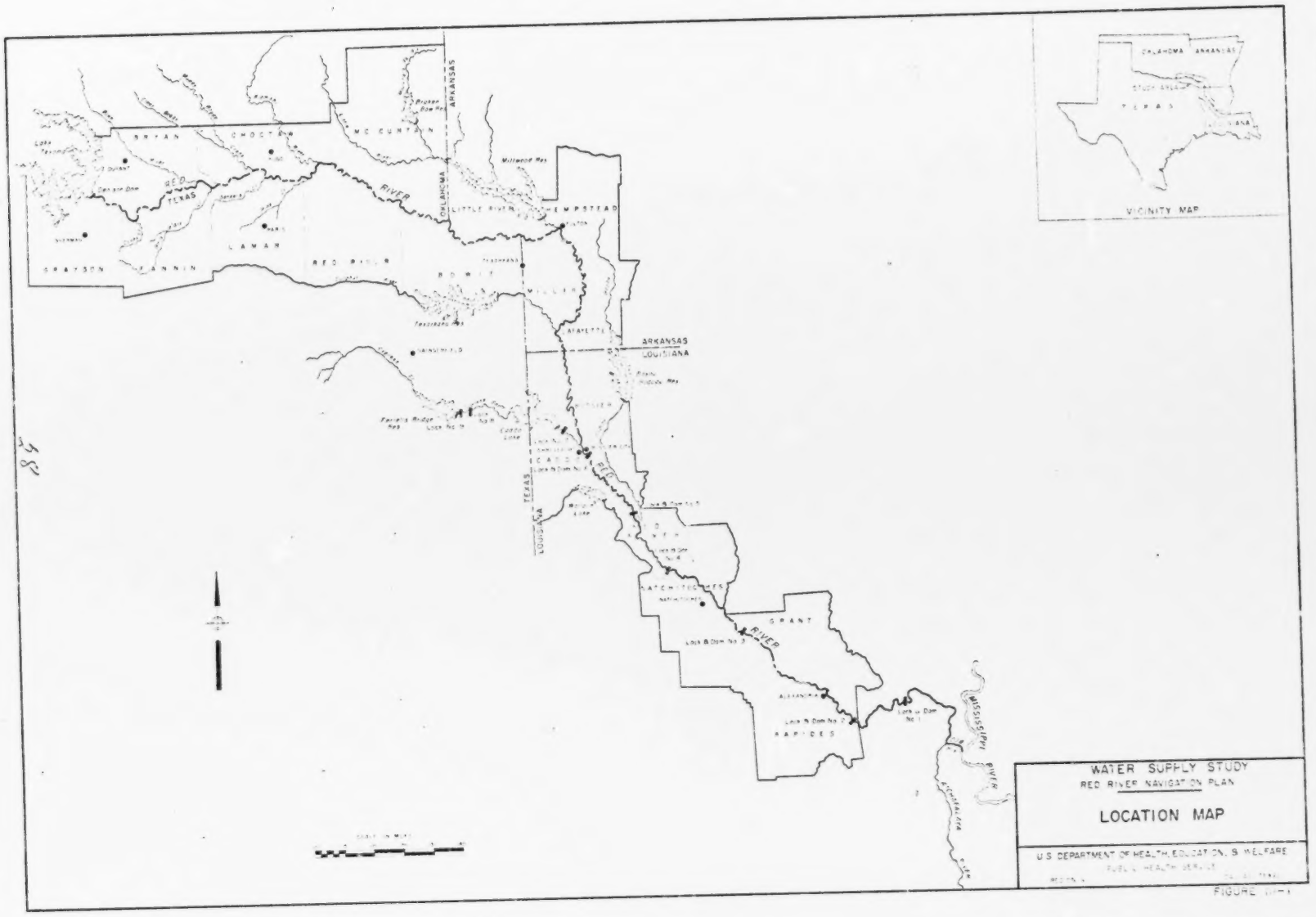
12. Economic Task Group of the ADHoc Water Resources Council Staff.

13. Public Health Service, "Water Quality Conservation, Arkansas-Red River Basins," Dallas, Texas, March 1964.

14. Babbitt, Harold E., and Doland, James J., Water Supply Engineering, New York, 1955.

15. Letter dated May 5, 1964, from A. A. Hirsch to the Corps of Engineers, New Orleans, Louisiana.

16. Letter dated October 5, 1964 from A. A. Hirsch addressed to the Public Health Service, Dallas, Texas.


OKLAHOMA
ARKANSAS
TEXAS
LOUISIANA
VICINITY MAP
BRYAN
CHOCTAW
MC CURTAIN
ARKANSAS
RED
TEXAS
RIVER
OKLAHOMA
LITTLE RIVER
HEMPSTEAD
LAMAR
RED RIVER
BOWIE
GRAYSON
FANNIN
MILLER
LAFAYETTE
ARKANSAS
LOUISIANA
CADDO
RED
RIVER
TEXAS
LOUISIANA
NATCHITOCHES
GRANT
RAPIDES
MISSISSIPPI RIVER
WATER SUPPLY STUDY
RED RIVER NAVIGATION PLAN
LOCATION MAP
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE

FIGURE

APPENDIX

Exhibit A

Treatment Costs

Present treatment costs (w/o proposed works) 16/ 2.0¢/1,000 gals.

Expected treatment costs (w/proposed works) 16/ 1.8¢/1,000 gals.

Estimated Savings 0.2¢/1,000 gals.

= $2.00/million gallons (M.G.)

Annual Value - 2025

High quality water use in area affected by Navigation Works = 120,450 M.G./year

Estimated savings in 2025 = $240,900

Discounting at 3 1/8 percent to 1975 (first use) the value to increasing water use, 1975 to 2025

$\frac{\$240,900}{50}$ x 485.79635 a/ = $2,340,600

Annual Value - 2075

High quality water use in area affected by Navigation Works = 251,850 M.G./year

Estimated savings in 2075 = $503,700

2025 worth of 2025 to 2075 savings

$\$240,900 \times 25.1301$ b/ + $\frac{\$262,800}{50} \times 485.79635$ a/

= $8,607,200

a/ Factor to determine the capitalized value or present worth of an increasing annuity from 1975 to 2025 using 3 1/8 percent interest rate.

b/ Factor to determine the capitalized value or present worth of an annuity of one (1) per year from 2025 to 2075 using 3 1/8 percent interest rate.

1975 worth of 2025 to 2075 savings

$8,607,200 x 0.21469 c/ = $1,847,900

1975 worth of 100-year savings

$2,340,600 + $1,847,900 = $4,188,500

Average annual value amortized over 100 years at 3 1/8 percent

$4,188,500 x 0.032760 d/ = $137,200

Pumping Costs

All water users to benefit - Average saving 8 feet of static head

2025 use from Red River in affected area

197,100 M.G./year

2075 use from Red River in affected area

352,225 M.G./year

Savings/M.G. = 1,000,000 gal. x 8.34 lb./gal. x 8 ft.
x 3.766×10^{-7} KWH/ft. - lb.
x $0.0075/KWH x 1/.85 = $0.222

Estimated savings in 2025 = $43,800

Estimated savings in 2075 = $78,200

Discounting at 3 1/8 percent to 1975 (first use) the value to increasing pumping, 1975 to 2025

$$\frac{\$43,800}{50} \times 485.79635 \text{ a/} = \$425,600$$

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a/ Factor to determine the capitalized value or present worth of an increasing annuity from 1975 to 2025 using 3 1/8 percent interest rate.

c/ Factor to determine the worth in 1975 by discounting the value in 2025 using 3 1/8 percent interest rate.

d/ Factor to determine the annuity for 100 years, associated with the 1975 value of benefits, using 3 1/8 percent interest rate.

2025 worth of 2025 to 2075 savings

$$\$43,800 \times 25.1301\ ^{b/} + \frac{\$34,400}{50} \times 485.79635\ ^{a/}$$

$$= \$1,434,900$$

1975 worth of 2025 to 2075 savings

$$\$1,434,900 \times 0.21469\ ^{c/} = \$308,100$$

1975 worth of 100 years savings

$$\$425,600 + \$308,100 = \$733,700$$

Average annual value amortizing over 100 years at 3 1/8 percent

$$\$737,000 \times 0.031646\ ^{d/} = \$23,200$$

733,1 0.032340 = 24,38 say $24,000

amortizing 1/2 of 50 yrs =

$16,900

.03179 = [illegible]

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a/ Factor to determine the capitalized value or present worth of an increasing annuity from 1975 to 2025 using 3 1/8 percent interest rate.

b/ Factor to determine the capitalized value or present worth of an annuity of one (1) per year from 2025 to 2075 using 3 1/8 percent interest rate.

c/ Factor to determine the worth in 1975 by discounting the value in 2025 using 3 1/8 percent interest rate.

d/ Factor to determine the annuity for 100 years, associated with the 1975 value of benefits, using 3 1/8 percent interest rate.